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Mail Section, Infantry Board file

REPORT

of

The Infantry Board

No. 1448

FRANGIBLE GRENADES, (VISCOLIZED OIL TYPE) AND IGNITERS

FORT BENNING, GEORGIA

February 2, 1943

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24725—Benning, Ga., 9-16-42—2,000

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Authority NND 763503

IB-471.6

February 2, 1943.

SUBJECT: Frangible Grenades, (Viscolized Oil Type) and Igniters.

TO: Chief of Ground Requirements Section, Army Ground Forces, Army War College, Washington, D. C.

1. The Infantry Board concurs with the answers to the questions contained in the inclosed questionnaire and the Discussion and Conclusions of the Test Section contained in Sections VI and VII of the attached Report of Test.

2. The results of the tests conducted indicate that:

a. The viscolized oil type grenade is more satisfactory than the alcohol-gasoline filled type.

b. The NP filled grenade with the M-3 Igniter is more satisfactory than any other combination tested.

3. Considering the effectiveness of the Grenade, Antitank, M9A1, the Rocket, Antitank, 2.36 inch, M6 and the future possibilities of larger antitank rockets, The Infantry Board is of the opinion that there is no requirement in the Infantry for a pre-fabricated, frangible, antitank grenade.

For the President:

M. J. GUNNER,
Colonel, Infantry,
Director.

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REPORT of TEST

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SERVICE TEST OF FRANGIBLE GRENADES, (VISCOLIZED OIL TYPE), AND IGNITORS

TEST SECTION
THE INFANTRY BOARD
FORT BENNING, GEORGIA

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Submitted to
THE INFANTRY BOARD

Copy No. 6 **Date** Jan. 27, 1943.

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TEST SECTION
THE INFANTRY BOARD
FORT BENNING, GEORGIA

JANUARY 27, 1943.

SUBJECT: [illegible]

TO: [illegible]

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I AUTHORITY AND REFERENCES

1. Authority.

a. 1st Ind., IB-471.6, The Infantry Board, November 28, 1942, (Appendix "A") to:

b. Letter, ONRMT-11/22762, Requirements Section, Hq., AGF, November 25, 1942, (Appendix "B") w/2 incl.

2. References:

a. Memo from CWS. 10-1-42, SPCEN 160/3017 w/1st and 2nd Ind. (Appx. "C").

b. Directive for Service Test and Attached Questionnaire, w/Instructions, (Appendix "D").

c. Infantry Board Report of Test No. 1231, July 12, 1941.

d. Infantry Board Report of Test No. 1355, May 25, 1942.

II PURPOSE OF TESTS

3. To determine:

a. The effectiveness of these munitions against modern tanks, and other mechanized vehicles.

b. The effect of extremes of temperature and wind velocity upon the effectiveness of these munitions.

c. Whether the Igniter, Grenade, M2, or the Igniter, Grenade, M3, is more satisfactory with the solid oil-filled frangible grenade.

d. Whether the AW grenade or the solid oil-filled grenade with external igniter is more satisfactory.

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e. Whether the IM or NP filling is the most satisfactory solid oil filling for the grangible grenade.

f. The answers to the Service Questionnaire.

III PERSONNEL

4. a. Major W. M. Myers, Test Section, The Infantry Board, conducted the tests and prepared this report.

b. Photographs were taken by the Field Reproduction Plant, Fort Benning, Georgia.

IV INTRODUCTORY INFORMATION AND DESCRIPTION OF PROJECT TESTED

5. Introductory Information.

a. Frangible type grenades were first tested by the Infantry Board during June, 1941, and reported in Infantry Board Report of Test No. 1231. None of the grenades tested were found suitable for Infantry use, but further development was recommended.

b. A second test was conducted on improved frangible grenades during May, 1942, and reported in Infantry Board Report of Test No. 1355. As a result of these tests The Infantry Board recommended, in part:

(1) "That the frangible type grenades, CA and AM filled, be given no further consideration for Infantry use...

(2) "That a more perfect gas-tight seal be developed for the frangible type grenade, FS filled, and that 50 of the improved type...be given a service test...

(3) "That tests of improved grenades against AFV be conducted at a place where such vehicles are available.

(4) "That frangible type grenades be considered unsuitable for use of Parachute and Airborne Infantry."

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g. On October 1, 1942, The Chief of the Chemical Warfare Service, in a memorandum to the CG, SOS., stated that new types of frangible grenades and igniters had been developed and requested that the AGF be contacted to determine what service boards should conduct service tests thereof. By 2nd Ind. the CG., AGF., designated the Infantry and Tank Destroyer Boards as test agencies.

h. The following test materials were received on November 23, 1942:

(1) 16 Grenades, Frangible, IM filled, w/M2 igniters.

(2) 16 Grenades, Frangible, IM filled, w/M3 igniters.

(3) 16 Grenades, Frangible, NP filled, w/M2 igniters.

(4) 16 Grenades, Frangible, NP filled, w/M3 igniters.

i. The test directive was received on November 29, 1942 and tests were initiated on December 1st. Tests were discontinued on December 12, 1942, to await the remaining test items. Since these materials had not been received by January 7, 1943, tests were continued using the materials then on hand.

j. No tanks or other "mechanized vehicles" could be secured for these tests.

6. Description of Project Tested.

a. See "Directive for Service Test", Appendix "D", attached, for detailed description of the test items.

b. A table of weights and measurements will be found in Test No. 1, following.

V DETAILS OF TEST AND RESULTS

7. Test No. 1.
December 1, 1942.

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a. Purpose: To determine the physical characteristics of the subject grenades and igniters.

b. Method: By weighing, measuring, and photographing.

c. Results:

(1) Weights and Measurements.

	Weight, Pounds	Dimensions Ht.	Dia.
(a) Grenade, IM filled, w/o igniter	1.33	7.5"	2.9"
M2 Igniter w/tape	.04	3.5"	0.6"
M3 Igniter w/clamp	.14	2.4"	0.5"
Grenade, IM, w/M2 igniter	1.37	7.5"	2.9"
Grenade, IM, w/M3 igniter	1.47	7.5"	2.9"
(b) Grenade, NP filled, w/o igniter	1.35	7.5"	2.9"
Grenade, NP, w/M2 igniter	1.39	7.5"	2.9"
Grenade, NP, w/M3 igniter	1.49	7.5"	2.9"

Note: The Infantry Board recommended a weight of 24 oz. (1.5 lbs.) as a maximum weight limit in Report of Test No. 1355.

(2) Appearance: See Plates 1 to 4 inclusive.

8. Test No. 2.
December 3, 1942.

a. Purpose: To determine the effect of high winds on the subject grenades and igniters.

b. Method: Twelve grenades, three IM-filled with M2 igniters, three IM-filled with M3 igniters, three NP-filled with M2 igniters, and three NP-filled with M3 igniters were fired on an afternoon during which the wind velocity averaged 28 mph, with frequent 40 mph gusts. The effect of the wind on the filling and on the igniters was noted.

c. Results:

(1) The high winds had no apparent effect on the functioning of the igniters.

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(2) Of the six NP-filled grenades, all burned satisfactorily in spite of the wind. The average burning time was five minutes.

(3) Of the six IM-filled grenades, one burned less than 30 seconds before being blown out by the wind, two burned approximately three minutes before being blown out, and three burned for approximately four and one-half minutes before being blown out. In no case was all of the material burned completely. It was noted that the thick film formed on the top of the IM when exposed to the air. This film prevented burning. The film was broken with a stick several times. The materials underneath immediately caught fire and burned until another film was formed.

(4) It was the opinion of the observers that the NP filling was superior to the IM filling where high winds might be encountered.

9. Test No. 3.
December 3, 1942.

a. Purpose: To determine the average burning time of the subject grenades.

b. Method: Two grenades, IM filled, and two grenades, NP filled, were ignited and allowed to burn out. The burning time was recorded.

c. Results:

(1) IM filled grenades:

No. 1	5' 40"
No. 2	6' 35"
Average	6' 7"

(2) NP filled grenades:

No. 1	5' 28"
No. 2	5' 48"
Average	5' 38"

(3) It was noted in this and other tests that the burning time varied considerably and depended upon the type of hit obtained, the dispersion of the gel, and the size of the area covered.

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10. Test No. 4.
December 4, 1942.

a. Purpose: To determine whether the subject grenades would set ammunition boxes on fire.

b. Method: Empty ammunition boxes were piled up to simulate a section of a depot. Two IM-filled grenades and two NP-filled grenades were thrown at the boxes and the results noted.

c. Results:

(1) The first grenade thrown, an NP-filled grenade, ignited the boxes which burned readily.

(2) The fire was extinguished and the boxes thoroughly soaked with water. A second NP grenade re-ignited the boxes after burning four (4) minutes.

(3) The first IM-filled grenade, thrown against dry boxes, readily ignited them.

(4) The fire was extinguished and these boxes also soaked with water. The second IM-filled grenade re-ignited the boxes after burning five (5) minutes.

(5) It was the opinion of observers that these grenades could be used as an incendiary against wooden objects.

11. Test No. 5.
December 10, 1942.

a. Purpose: To determine the effect of high temperatures on the subject grenades.

b. Method: Two of each type of grenade, one with an M2 igniter, and one with an M3 igniter were placed in a laundry drying room at a temperature of 120° F. and left for six hours. They were then ignited and the results noted.

c. Results:

(1) All grenades ignited immediately and burned satisfactorily. No ill effects from their exposure to the high temperatures could be detected.

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(2) It was the opinion of observers that these grenades were satisfactory for use in theaters where high temperatures are to be expected.

F. Test No. 6.
December 12, 1942.

A. Purpose: To determine the effect of cold temperatures upon the subject grenades.

B. Method: Four grenades having IM filling, and four grenades having the NP filling (two each with M2 igniters and two each with M3 igniters) were placed in a cold storage chamber at a temperature of 10° F. and left for a period of 24 hours. Efforts were made to ignite them and the results were noted.

C. Results:

(1) Table--

Grenade filling	Igniter	Functioning Igniter	Functioning Grenade	Remarks
IM	M2	Yes	Yes	Ignition was delayed ten seconds. Filling looked like jelly.
IM	M2	Yes	Failed to ignite	Filling was congealed. It did not spread, but remained in an area about one foot in diameter.
IM	M3	Yes	Do	Same as above.
IM	M3	Yes	Do	Same as above.
NP	M2	Yes	Satisfactory	Viscosity appeared to be unaffected by the cold.
NP	M2	Yes	Do	
NP	M3	Yes	Do	
NO	M3	Yes	Do	

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(2) The exposure to below-freezing temperatures congealed the IM filling to such an extent that three out of four grenades failed to ignite. The spread of the filling was unsatisfactory. It closely resembled frozen custard in appearance and consistency.

(3) The NP filling was apparently unaffected by the cold. Its viscosity appeared to be unchanged. Its spread and 'stickiness' were satisfactory.

(4) It was the opinion of the test officer that the NP filling was satisfactory when employment in cold climates was necessary, but that the IM filling was entirely unsatisfactory for this use.

F. Test No. 7.
January 12, 1943.

1. Purpose: To determine:

(1) The relative interference of the Igniters, M2, M3, and Internal (AW type) with accurate throwing.

(2) The relative effectiveness of throwing the grenade (a) like a football and (b) overhand off the tips of the fingers as recommended in Infantry Board Report of Test No. 1358.

2. Method: Six enlisted men were instructed in methods of throwing the subject grenades and were each given one hour of practice throwing. Thirty-six water-filled bottles representing the subject grenades were made up, twelve with the M3 igniter, twelve with the M2 igniter, and twelve with no igniter (representing the AW grenade). An M3 Medium Tank was secured. The grenadiers selected positions five, ten, and fifteen yards from a road along which the tank was to travel and dug foxholes which were later camouflaged. Two grenades of each type, six in all, were thrown by each man as the tank moved down the road at a speed of 10-15 mph. A record of the results was kept and the opinions of the grenadiers obtained through a questionnaire.

3. Results:

(1) Table.

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Rd. No.	Igniter	Throwing Method	Grenades Thrown	Misses	% of Misses
1	AW	Like football	6	0	0
2	AW	Overhand	6	0	0
3	M3	Like football	6	1	16-2/3%
4	M3	Overhand	6	0	0
5	M2	Like football	6	2	33-1/3%
6	M2	Overhand	6	2	33-1/3%

(2) All grenadiers were unanimous in their opinion that the M2 igniters interfered most with accurate throwing, and that the AW type could be thrown most accurately.

(3) Four of the six men preferred to throw the grenade like a football rather than overhand off the fingers. The test officer noted (1) that of 18 grenades thrown by each method fifteen hits were scored when the grenades were thrown like a football while sixteen hits were scored when the grenades were thrown overhand, (2) that none of the grenades could be made to "spiral", and (3) that the four men who preferred to throw the grenades like a football had played football in high school or college while the two men who preferred to throw the grenades overhand had never played football.

(4) It was further noted that in the practice throwing, more accurate results were obtained when the grenades were thrown overhand.

14. Test No. 8.
January 13, 1943.

a. Purpose: To record the effect of the water bottles representing the subject grenades on an M3 medium tank.

b. Method: Permission to use the subject grenades on a current tank could not be obtained. In order to secure some data on the subject the effect of the 36 grenades thrown in Test No. 6 above was noted and recorded.

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g. Results:

(1) Water from the practice grenades penetrated the interior of the tank at the following points:

(a) Around the driver's port.

(b) Around the 75-mm gun shield.

(c) Around the left side door.

(d) Around the 37-mm gun shield.

(2) One-half of the tank floor was wet. Water covered about one-third of the dash. The driver was spattered with water. The top of the radio receiver was covered with water. The 75-mm gun gunner's seat was wet.

(3) The periscope head of the 75-mm gun sight was broken by a direct hit, as was the glass in the driver's port.

15. Test No. 9.
January 15, 1943.

a. Purpose: To record the opinions of The Infantry School on the subject grenades.

b. Method: Twenty grenades were turned over to representatives of The Infantry School with an appropriate questionnaire.

c. Results:

(1) It was the opinion of The Infantry School that:

(a) The size and weight of the igniters and fillings of the subject grenades were satisfactory for accurate throwing.

(b) The gel would function better if thinner.

(c) The M3 igniter is superior to the M2 igniter when IM is used to viscolize the gasoline.

(d) The M3 igniter is superior to the M2 igniter when NP is used to viscolize the gasoline.

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(e) The M3 igniter is superior to the M2 igniter for grenades improvised in the field.

(f) The Zimmerman clamp of the M3 igniter does not interfere with throwing of the grenade.

(g) That the suggested method of throwing a grenade like a football is satisfactory.

(2) The following comment was appended to the report: "This grenade seems suitable for setting fire to buildings, wooden bridges, etc., by being thrown from moving vehicles."

16. Test No. 10.
January 16, 1943.

a. Purpose: To determine the effect of water on the subject grenades.

b. Method: Two of each type of grenade were placed in a pool of water and left for a period of 24 hours. They were then removed and efforts made to ignite them. Results were noted.

c. Results:

(1) M2 igniters:

(a) Both M2 igniters on the NP-filled grenades functioned perfectly.

(b) One of the M2 igniters on the IP-filled grenade failed to function. It was noted that the waxed paper on this igniter had been torn. The other functioned but failed to ignite the gel.

(2) M3 igniter:

(a) One M3 igniter on the NP-filled grenade functioned perfectly. The other failed to detonate, altho the primer was struck by the firing pin.

(b) One M3 igniter on the IP-filled grenade functioned perfectly. The other failed to detonate.

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(3) The following conclusions were drawn:

(a) The waxed paper protects the M2 igniter satisfactorily, but is apt to be torn.

(b) The cartridge in the M3 igniter is not sufficiently waterproof. This should be easily corrected.

17. Test No. 11.

a. Purpose: To determine the relative effectiveness of the M2 and M3 types of igniters with IM-filled and NP-filled grenades.

b. Method: Records were kept on the functioning of all grenades expended. At the conclusion of the tests these records were studied and the relative effectiveness of the two types of igniters determined.

c. Results:

(1) See Appendix "B" for the detailed record.

(2) Resume of failures:

(a) M2 igniter:

	Grenades Used	Malfunctions Number	%
On NP-filled grenade	14	3	21%
On IM-filled grenade	14	6	43%
Average	28	9	32%

(b) M3 igniters:

On NP-filled grenades	14	1	7%
On IM-filled grenaded	14	3	21%
Average	28	4	14%

(3) It will be noted that the M3 igniter is more dependable than the M2. An insufficient number of grenades was furnished to secure reliable percentages.

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18. Test No. 12.
January 18, 1943.

2. Purpose: To answer Service Questionnaire.

3. Method: Information needed was extracted from results of tests conducted. Where such information was not available in the current tests, as in the case of the AW grenades, results of tests conducted by the Infantry Board at an earlier date were utilized.

4. Results:

(1) Question: Is the size of the grenade and the weight of the igniters and fillings satisfactory for accurate throwing?

Answer: Yes. The size and weight are considered ideal.

(2) Question: What is the effect of temperature upon the functioning of the igniters and the AW grenade?

Answer: Warm or hot temperatures appear to have no effect on either the igniters or the viscolized gasoline. Cold, however, while it does not affect the functioning of the igniters as such, so congeals the IM viscolized gasoline that ignition is nearly impossible. Since the AW grenade has an IM filler, trouble from ignition may be expected.

(3) Question: What is the effect of extremes of temperature upon the stickiness of the viscolized gasoline?

Answer: The NP viscolized gasoline does not appear to be affected by extremes of temperature. The IM viscolized gasoline, however, while satisfactory in hot weather, congeals in below-freezing temperatures to a custard-like consistency, making ignition very uncertain and its spread unsatisfactory.

(4) Question: Is the gasoline gel always ignited?

Answer: No. See Test No. 9.

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(5) Question: Does the gasoline gel stick effectively to surfaces?

Answer: Yes.

(6) Question: What is the percentage of gel ignited?

Answer: This depends upon the type of hit obtained. It will average 80 - 90%.

(7) Question: Would the gel function better if thinner or thicker?

Answer: The consistency of the M1 gel appears about right. The M4 is too thick.

(8) Question: Is the M3 igniter better than the M2 igniter when it is used to viscolize the gasoline?

Answer: Yes.

(9) Question: Is the M3 igniter better than the M2 igniter when M2 is used to viscolize the gasoline?

Answer: Yes.

(10) Question: Is the M2 or M3 igniter better for use with grenades improvised in the field?

Answer: The M2, while less dependable than the M3, is more adapted to use with improvizations. See par. 23, below.

(11) Question: Are the viscolized oil-filled frangible grenades with the M2 or M3 igniter better than the AN frangible grenade?

Answer: Yes. They are safer, and more dependable when the M3 igniter is used.

(12) Question: Does the Timmerman clamp on the M3 igniter interfere with the throwing of the grenade?

Answer: To some extent, yes. It interferes less than the M2 igniter. Anything on the outside of the bottle interferes with accuracy.

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(13) Question: Does the white phosphorus in the AN grenade have any other effect upon a moving tank other than as an igniter; in other words, does the smoke serve any use?

Answer: No. It was thought that the smoke might be useful in blinding the driver. Experiments with HC smoke on a moving tank show that the smoke is blown past the drivers port and does not obscure vision for more than a few seconds. See Infantry Board Report of Test No. 1231.

(14) Question: Is the suggested method of throwing a grenade like a football satisfactory?

Answer: For former football players, yes. Tests indicate that for others, greater accuracy is attained when the grenade is thrown either underhand or overarm with the palm of the hand perpendicular to the line of flight, the grenade being allowed to roll off the fingertips. From a prone position or from a position in a foxhole, the overarm throw is the best. Former football players will invariably throw the grenade like a football unless closely watched.

(15) Question: Will the grenade slow down or stop a tank?

Answer: Unknown. Permission to use the grenades on a "live" tank could not be obtained. The opinion of tankers consulted was as varied as the number interviewed.

(16) Question: Please list any uses for this munition which have not been suggested.

Answer: The grenade is effective as an incendiary against wooden objects such as ammunition boxes, frame structures, etc.

(17) Question: Any other comments?

Answer: See discussion following.

10. Test No. 14.
January 18, 1943.

a. Purpose: To record additional data on the functioning of the M2 igniter.

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b. Method: Two hundred M2 igniters were furnished The Infantry Board for informal test during the month of July, 1942. These igniters were turned over to The Infantry School for use in demonstrations. Periodic reports were requested on the functioning of the igniters.

c. Results:

(1) Summary of reports:

(a) Total number of igniters fired --- 147 ..... 100%

(b) Grenades successfully ignited --- 101 ..... 68.7%

(c) Malfunctions --- 46 ..... 31.3%

Misfires due to scratcher not functioning	25
Wet igniters	11
Igniter and portion of bottle flying away from gas mixture before ignition	5
Gas mixture affecting igniter	2
Cause unknown	3

(2) It will be noted that the percentage of failure here recorded is to all intents and purposes identical with that reported in Test No. 9, above.

VI DISCUSSION

30. General.--Since the effectiveness of these munitions against modern tanks and other mechanized vehicles could not be ascertained at this station, that part of the directive calling for such information cannot be complied with. This report is confined to a determination of the relative excellence of the

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different types of grenades and igniters furnished, and to a statement of opinion as to the uses to which these grenades and igniters might be put.

21. Statement of Advantages and Disadvantages.

a. Viscolized gasoline fillers for frangible grenades.

(1) NP filler (used with M2 and M3 igniters).

(a) Advantages.—

The "stickiness" of this filler is satisfactory.
It is not affected by extremes of temperature.
It functions well in high winds.
Its viscosity is satisfactory.

(b) Disadvantages.—None were disclosed by test.

(2) IM filler (used with M2 and M3 igniters, and in the A4 grenade).

(a) Advantages.—

The "stickiness" of this filler is satisfactory.

(b) Disadvantages.—

It congeals in low temperatures.
It was blown out by high winds.
It was too thick, in the opinion of the test officer, for maximum effectiveness.
It is not as easily ignited as the NP.
A thick skin forms over it when exposed to air. This frequently prevents complete combustion.

b. Igniters.

(1) M2 igniters.

(a) Advantages.—

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It can be attached to any type of frangible container.
Its safety features are satisfactory.
It is made of non-critical materials.
As long as the waxed paper cover is intact, it is waterproof.

(b) Disadvantages.--

It is not positive in action. 32% failures were experienced.
It interferes with accuracy in throwing.
It is difficult to time the pull cord actuation.
Its waxed paper cover is easily torn.

(2) M3 igniter.

(a) Advantages.--

It is superior to the M2 igniter in effectiveness.
Its safety features are satisfactory.

(b) Disadvantages.--

It can be used only with containers between 3-3/4" and 3-1/4" in diameter.
It is of metal, a critical material.
It interferes slightly with accuracy in throwing.
The cartridge is not adequately waterproofed.

(3) Internal white phosphorus (AW type).

(a) Advantages.--

This igniter does not interfere with accuracy in throwing.
It is waterproof.

(b) Disadvantages.--

It is not positive in action. (See Report of Test No. 1355).
Its safety features are unsatisfactory. If the container is broken in transport the mixture will ignite.

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a. From the standpoint of effectiveness under the widest range of conditions, the WP filled grenade equipped with the M3 igniter is superior to any of the other combinations submitted for test. It is the opinion of the Test Section that this combination is also superior to the AW grenade.

23. Frangible Grenades vs. Grenade, Antitank, M9A1.

a. In the absence of factual data derived from actual firings against tanks and other vehicles, it is the opinion of the Test Section, based on tests against simulated tanks with the actual grenades, and against tanks with simulated grenades, that the M9A1 grenade is more effective against tanks than any viscolized gasoline-filled frangible grenade so far tested. If this opinion is correct, it would appear advantageous to utilize available shipping space to send M9A1 grenades to the theaters of operation, rather than pre-fabricated frangible grenades. It is the opinion of the Test Section that the need for an incendiary frangible antitank grenade ceased to exist with the adoption of the grenade, antitank, M9A1.

b. Attention is invited to Infantry Board Report of Test No. 1355. In that report it was recommended that development of gasoline-filled and AW grenades be discontinued, but that FS-filled grenades be provided for further tests. The opinion stated in the paragraph above does not include the FS-filled frangible grenade.

24. Improvised grenades.

a. Situations may be foreseen when, due to lack or exhaustion of supplies of M9A1 grenades, a need for incendiary frangible antitank grenades might arise. This need should be met by improvisation. As long as the policy of furnishing soldiers with beer thru the Post Exchange system continues, a supply of suitable containers and caps will be available. Gasoline must be furnished for the motor transport. The viscolizing element and the igniters are the only components not easily obtainable.

b. Experience has shown that satisfactory improvised igniters are rarely obtained. Since igniters furnished with the subject grenades were light and small, the Test Section believes that it would be expedient to provide a supply of these items for this and other uses to which they might be adapted. For use with the subject grenades, the M3 igniter is superior to the

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M2 igniter. However, it is made of metal, its clamp limits its use to bottles between 3-3/4 and 3-1/4 inches in diameter, and it is by its very design restricted to this use, and this use only. The M2 igniter, while not as dependable as the M3, is easily attached to any frangible container, is much more flexible and ada ted to other uses. It is the opinion of the Test Section that this igniter should be improved and issued to the Infantry.

g. The Test Section has no information on the nature of the NP viscolizing agent. It is possible that this item might be furnished with the igniters.

VII CONCLUSIONS

24. The Test Section concludes:

a. That the NP-filled grenade is not affected detrimentally by extremes of temperatures and wind velocity.

b. That the IM-filled grenade is detrimentally affected by extremes of temperatures and wind velocity.

c. That the Igniter, M3, is superior to the Igniter, M2, when used with solid oil-filled frangible grenades.

d. That the solid oil-filled grenade with external igniter is superior to the AW grenade.

e. That the NP filling is superior to the IM filling for frangible grenades.

25. No conclusions could be drawn as to the effectiveness of the test items against modern tanks and other mechanized vehicles.

H. G. SYDENHAM,
Colonel, Infantry,
Chief of Test Section.

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[illegible]

1st Ind.

[illegible]
(AG-C-A)
[illegible], Fort Benning, Georgia, November 20, 1940.
To: Chief of Test Section, The Infantry Board, Fort Benning, Georgia.

1. It is requested that your section conduct tests of the subject Portable Grenades and Igniters as directed in paragraph 4, basic communication.

2. Upon completion of the tests report will be rendered the Infantry Board.

3. Lt. Col. Joel Flair is the member of the Infantry Board charged with this project.

For the President:

E. A. [illegible],
Lt. Col., Infantry,
Acting Recorder.

2 Incls. n/c.

[illegible]

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Headquarters
Army Ground Forces
Washington, D. C.

November 25, 1942.

SUBJECT: Service Test of Frangible Grenades, (Viscolized Oil Type), and Igniters.

TO: The President, The Infantry Board, Fort Benning, Georgia.

1. Attention is directed to the inclosed copy of a memorandum from the Chief, Chemical Warfare Service to the Commanding General, Services of Supply on the above subject, and the 1st and 2d indorsements thereto. (Inclosure No. 1).

2. The Infantry Board and the Tank Destroyer Board have been designated to conduct the service test of these grenades and igniters. Advice has been received that the grenades were shipped on November 12, 1942.

3. The viscolized oils have proved to be far superior to the alcohol-gasoline filling originally tested in frangible grenades. It has a quality of sticking to the object struck and burning fiercely for a considerable length of time.

4. The new type igniter which has been developed is thought to be superior to the old type and better suited to the frangible grenade.

5. It is desired that the subject grenades and igniters be service tested by the Board with view to determining the data required in the inclosed questionnaire (Inclosure No. 2). Also, in view of the fact that the alcohol-gasoline filled frangible grenade was found unsatisfactory in previous tests, it is desired that the Board state whether the viscolized oil type is considered satisfactory and is recommended for adoption for Infantry troops. If so, a basis of issue should be recommended.

For the Chief, Ground Requirements Section:

/s/ W. F. Dean
W. F. Dean
Colonel, G.S.C.
Executive

2 Incls:
Incl. 1, Memo fr CWS, 10-1-42, AGRH 1x/2017 w/1st and 2d Inds.
Incl. 2, Directive for Service Test, and attached Questionnaire, w/Instructions.

Ground Requirements Section

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ATTACHMENT "B"

WAR DEPARTMENT
OFFICE OF THE CHEMICAL WARFARE SERVICE
Washington, D. C.

In reply refer to
WCWH 160/7017
(10-1-42)

CWS/ype/6504

October 1, 1942.

Memorandum for the COMMANDING GENERAL, SERVICES OF SUPPLY.

(Attention: Chief, Development Branch, Requirements Division.

Subject: Service Test of Frangible Grenades and Igniters.

1. Reference is made to the minutes of Chemical Warfare Technical Committee meeting held September 30, 1942. Incendiary Oil, M, and Incendiary Oil, M, were recommended as standard and substitute standard fillings, respectively, for the M1 frangible grenade. These viscolized oils are to replace the alcohol-gasoline filling which is to be declared obsolete. Also, a railroad fuzee type igniter, the M2, was recommended for use with the viscolized oil fillings in place of a chromic anhydride igniter, the M1, which had been specified for use with the alcohol-gasoline filling.

2. At the meeting referred to above, it was stated that engineering tests have been conducted at Edgewood Arsenal on viscolized oil-filled frangible grenades equipped with a new type igniter. The latter consists of a small metal barrel fastened to the grenade by a special clamp. The barrel contains a 38-caliber blank cartridge, a firing pin, and a spring. The clamp also serves as a trigger, so that when the bottle is broken, the clamp is loosened and the spring causes the firing pin to discharge the cartridge. A safety pin is provided on the igniter. The results of these tests were satisfactory, and it was suggested that this new igniter (to be known as Igniter, Grenade, Frangible, M3) replace the present M2 igniter. As it would be highly desirable to have only one incendiary filling for frangible grenades, it was also suggested that the viscolized oil-filled grenades equipped with the M3 igniter be issued to those branches which now have a requirement for A-filled grenades.

3. In order to decide what action should be taken on the above suggestions, it is felt that service tests should be conducted on viscolized oil-filled grenades with M3 igniters, viscolized oil-filled grenades with M2 igniters, and A-filled grenades. As a result of such tests, the following questions could be answered:

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a. Is the M3 igniter better than the M2 for use with viscolized oil-filled grenades?

b. Is the viscolized oil-filled grenade provided with the M3 igniter more satisfactory than the AN-filled grenade?

c. Is the M3 igniter more satisfactory than the M2 for use with grenades which are improvised in the field?

A directive is being prepared that will cover the conducting of the tests in such a manner that the above-listed questions can be definitely answered.

4. It is requested that the Army Ground Forces and, also, the Corps of Engineers be contacted for the purpose of determining which boards will service test the subject grenades and igniters.

For the Chief of the Chemical Warfare Service:

/s/ W. G. Kobrich,

W. G. KOBRICH,
Colonel, C. W. S.,
Chief, Technical Division.

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Subject: Service Test of Frangible Grenades and Igniters

SPGN 471.6 (11-1-42) 1st Indorsement Date: 7 Dec 42

Headquarters, Services of Supply, Washington, D. C.
To: Commanding General, Army Ground Forces - Attention: Development Division, Requirements Section.

1. It is requested that you designate one or more of your Boards to conduct service tests on the frangible grenades and igniters commented upon in the basic communication.

For the Commanding General:

W. A. [illegible], Jr.,
Brigadier General, General Staff Corps,
Director, Requirements Division

/s/ R. R. Robins

R. R. Robins
Colonel, General Staff Corps,
Chief, Development Branch.

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471.6/278 - [illegible]/1840
(10-1-40)

2nd Ind. 4

[illegible], Army War College, Washington, D. C.
To: The Commanding General, Services of Supply (Attention: Development Branch, Requirements Division).

1. The Infantry Board and the Tank Destroyer Board are designated as the Boards to service test the subject items.

2. It is requested that this Headquarters be notified when the prototypes are shipped so that directive may be forwarded to the Boards.

For the [illegible]:

[illegible]

APPENDIX "C"

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[illegible] FOR [illegible]

Igniter, Grenade, M2
Igniter, Grenade, M3
Grenade, Frangible (IF), M1
Grenade, Frangible (NF), M1
Grenade, Frangible (SF), M1

Section I
General Description

I. General.

This directive has been written to assist in the service testing of the Igniters, Grenade, M2 and M3, used with both the Grenade, Frangible, (IF), M1 and the Grenade, Frangible (NF), M1 and also to assist in the service testing of the Grenade, Frangible (SF), M1.

II. Object.

A. To determine the effectiveness of these munitions against modern tanks, and other mechanized vehicles.

B. To determine the effect of extremes of temperature and wind velocity upon the effectiveness of these munitions.

C. To determine whether the Igniter, Grenade, M2 or the Igniter, Grenade, M3 is more satisfactory with the solid oil-filled frangible Grenade.

D. To determine whether the AP Grenade or the solid oil-filled Grenade with external igniter is more satisfactory.

E. To determine whether the IF or the NF filling is the most satisfactory solid oil filling for the frangible Grenade.

F. To determine other types of objectives suitable to these munitions.

III Authority.

By order of the Chief, Chemical Warfare Service ([illegible] 160/3017, [illegible], Sept. 14, 1942, Subject: Incendiary Grenade Igniters, to [illegible], and ind. thereto.)

IV. Description of Munitions.

A. Grenade, Frangible (IF), M1. The Grenade, frangible, M1 consists of a glass bottle with crown cap closure, holding approximately 16 fluid ounces of a viscolized gasoline filling, (IF).

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B. Grenade, Frangible (WP), M1. The grenade, frangible, M1 consists of a glass bottle with crown cap closure, holding approximately 16 fluid ounces of a viscolized gasoline filling (WP).

C. Igniter, Grenade, M2. The M2 grenade igniter consists of a small railroad fusee (small parade torch) fitted with a pullwire for ignition. The fusee is taped on to the frangible grenade. To use the grenade, the pullwire is pulled, igniting the fusee and the grenade is hurled. On impact the grenade bottle is broken and the fusee ignites the viscolized gasoline.

D. Igniter, Grenade, M3. The M3 grenade igniter consists of a small metal barrel fastened to the grenade by a special clamp. In the barrel is contained a 50-caliber blank cartridge, a firing pin and a spring. The clamp also serves as a trigger, so that when the bottle is broken, the clamp is loosened and the spring causes the firing pin to discharge the cartridge. A safety pin is provided on the igniter. (See Instructions for Attaching and Using Igniters to Hand Incendiary Grenades accompanying this Directive.)

E. Grenade, Frangible (AP), M1. The AP frangible grenade consists of a glass bottle with crown cap closure containing approximately 4 fluid ounces of white phosphorus covered by approximately 12 fluid ounces of IM viscolized gel. On impact the bottle is broken, the white phosphorus ignites and in turn ignites the IM.

V. Trial Tests.

Preliminary tests of these munitions have been conducted at Edgewood Arsenal.

VI. Method of Using.

A. The M1 frangible grenade with IM or WP require external igniters, either the M2 or M3.

B. The AP frangible grenades require no external igniters.

C. The M2 igniter is taped to the grenade with two pieces of adhesive tape. The pullwire is pulled immediately prior to hurling the grenade. The igniter burns for 30-45 seconds.

D. The safety pin on the M3 igniter should not be removed until just before hurling the grenade.

E. The frangible grenades are hurled like a football in order that maximum range and accuracy can be secured. Only direct hits are effective against moving vehicles.

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VII. Suggestions for specific tests.

A. These munitions have been tested against stationary simulated tanks.

B. The effectiveness of these munitions against tanks should be tested, also against trucks and other vehicles. The effect of the grenades when impacted on various parts of the tank, particularly when the burning gel enters through the motor vent grill in the rear of the turret, should be determined.

C. The ability of these grenades to start fires in inflammable structures and other materials should be determined.

D. The effective concentration of burning gel that can be laid on a moving tank by a given number of men, using the M6; M3 ignited grenades and the AT grenade, should be determined comparatively, so that the best type can be decided upon.

VIII. Notes.

A. The consistency and stickiness of the viscolized gasoline in the AT, IB, and HP frangible grenades can be altered, if deemed necessary, by changing the proportions of the constituents.

B. The M3 igniter is attached to improvised grenade by means of a special tool clamp. Instructions for doing this are given in an attached sheet.

IX. Data sheets and recommendations.

The questions attached are to provide an opportunity for the free expression by observers of their views and impressions of this munition. Any additional tests which may aid in determining tactical uses for these munitions should be made and reported.

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Section II
Questionnaire

The following questionnaire is intended to elicit essential information regarding the military value of the igniter and grenade. Answers to the questions and suggestions for correcting each defect reported are requested.

1. Is the size of the grenade and the weight of the igniters and fillings satisfactory for accurate throwing?

2. What is the effect of extremes of temperature upon the functioning of the igniters and the AN grenade?

3. What is the effect of extremes of temperature upon the stickiness of the viscolized gasolines?

4. Is the gasoline gel always ignited?

5. Does the gasoline gel stick effectively to surfaces?

6. What is the percentage of gel ignited?

7. Would the gel function better if thinner or thicker?

8. Is the M3 igniter better than the M2 igniter when IN is used to viscolize the gasoline?

9. Is the M3 igniter better than the M2 igniter when NP is used to viscolize the gasoline?

10. Is the M2 or M3 igniter better for use with grenades improvised in the field?

11. Are the viscolized oil-filled frangible grenades with the M2 or M3 igniter better than the AN frangible grenade?

12. Does the Timmerman clamp on the M3 igniter interfere with the throwing of the grenade?

13. Does the white phosphorus in the AN grenade have any other effect upon a moving tank other than as an igniter, in other words, does the smoke serve any use?

14. Is the suggested method of throwing a grenade like a football satisfactory?

15. Will the grenade slow down or stop a tank?

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16. Please list any uses for this munition which have not been suggested.

17. Any other comments?

Submitted by:

/s/ George S. Hiles
GEORGE S. HILES
Chemical Munitions Section

Recommending approval:

/s/ R. L. Ortynsky
1st Lt. CWS,
for J. P. ADAMS
Major, C.W.S.,
Chief, Chemical Munitions Section.

Edgewood Arsenal, Md.
October 31, 1942

/s/ F. V. Gerhard
F. V. GERHARD
Colonel, C.W.S.
Chief, Munitions Development Division

Approved:

/s/ Hubert R. Drexel
HUBERT R. DREXEL
Colonel, C.W.S.
Chief, Research & Development Dept.

1 Encl.
Instructions for
Attaching and Using
Ignition Unit and Incen-
diary Grenade.

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APPENDIX "D"

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FUNCTIONING OF M2 AND M3 IGNITERS

1. M2 Igniter.	Malfunctions	Remarks
a. [illegible] filled grenades:		
No. 1	Yes	Fuse pulled out of oiled paper without igniting.
No. 2	None	
No. 3	None	
No. 4	None	
No. 5	None	
No. 6	None	
No. 7	None	
No. 8	Yes	Pull wire could not be pulled out of case.
No. 9	None	
No. 10	None	
No. 11	None	
No. 12	None	
No. 13	Yes	Pull wire broke.
No. 14	None	

Failures - 21%

b. [illegible] filled grenades:		
No. 1	Igniter fired but did not ignite gell.	Burning igniter was held away from gell by bottle fragments and tape. Failed to ignite gell.
No. 2	Yes	Igniter exploded when cord was pulled and burned out in about five seconds.
No. 3	None	Ignition was delayed. Reason not ascertained.
No. 4	Igniter fired but did not ignite gell.	On cold test. Gell was congealed.
No. 5	None	
No. 6	Yes	Pull wire would not come out of case.
No. 7	None	

APPENDIX "E"

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	Malfunctions	Remarks
No. 8	Yes	Igniter functioned but failed to ignite gel.
No. 9	None	
No. 10	None	
No. 11	None	
No. 12	Yes	Pull wire would not come out of case.
No. 13	None	
No. 14	None	

Failures - 43%

2. [illegible] Igniter.

a. [illegible] filled grenade:

No. 1	None	
No. 2	None	
No. 3	Detonated but did not ignite.	Flame was apparently directed away from the gell.
No. 4	None	
No. 5	None	
No. 6	None	
No. 7	None	
No. 8	None	
No. 9	None	
No. 10	None	
No. 11	None	
No. 12	None	
No. 13	None	
No. 14	None	

Failures - 7%

b. [illegible] filled grenades:

No. 1	None	
No. 2	None	
No. 3	None	
No. 4	Detonated but failed to ignite gel.	On cold test. Gel was congealed.

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	Malfunctions	Remarks
No. 5	Detonated but failed to ignite gel.	On cold test. Gel was congealed.
No. 6	None	
No. 7	None	
No. 8	None	
No. 9	None	
No. 10	Detonated but failed to ignite gel.	
No. 11	None	
No. 12	None	
No. 13	None	
No. 14	None	

Failures - 21%

3. Causes of failures:

a. [illegible] Igniters

(1) On M[illegible] filled grenades 21%
(2) On IM filled grenades 43%
(3) Total average 32%

b. [illegible] Igniters

(1) On M[illegible] filled grenades 7%
(2) On IM filled grenades 21%
(3) Total average 14%

APPENDIX "E"

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RESTR[illegible]

a b c d

a - Grenade, Frangible (IM) M1 with M2 igniter.

b - Grenade, Frangible (IM) M1 with M3 igniter.

c - Grenade, Frangible (NP) M1 with M2 igniter.

d - Grenade, Frangible (NP) M1 with M3 igniter.

Plate 1

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Frangible Grenades.

Close-up of Igniter, M2

Plate 2

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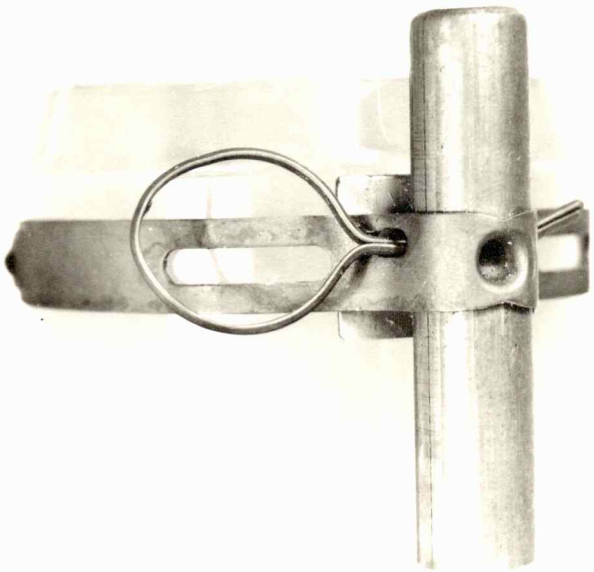

Frangible Grenades.

Close-up of Igniter, M3

Plate 3

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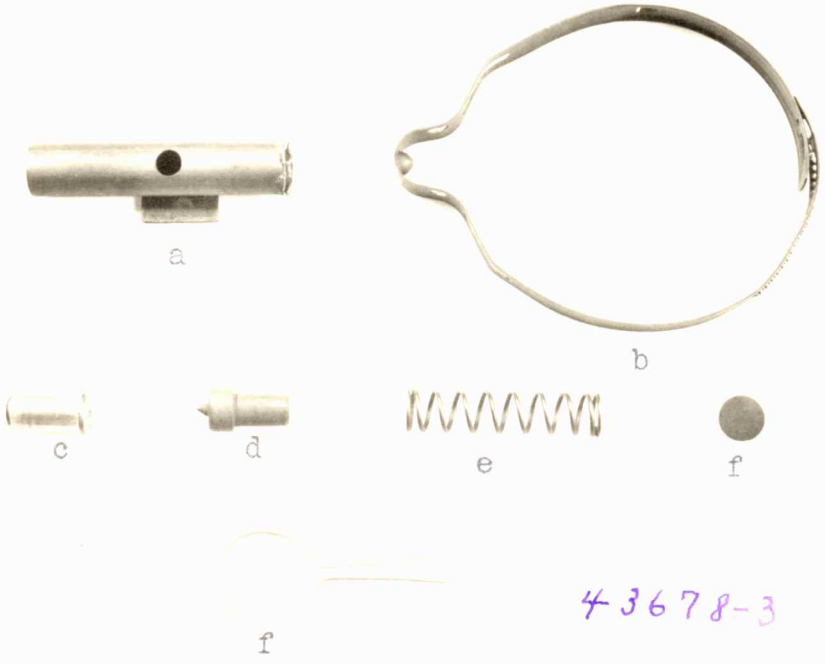

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Frangible Grenades

Parts of Igniter, M-3

a. Metal barrel

b. Timmerman clamp

c. Cal. .38 blank cartridge

d. Firing pin

e. Firing pin spring

f. Barrel cap

g. Safety pin.

Plate 4.

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